

CLAIMS

1. A lighting system for irradiating pixels of an image display element with outgoing light, said lighting system comprising:

a linear light guiding body for converting light from a light source unit into a linearly emitting state; and

a planar light guiding body in which a cyclic structure for converting light from said linear light guiding body into a planarly emitting state and emitting the converted light is formed,

wherein light from said linear light guiding body reaches a peak value of luminance when outgoing in a first outgoing direction, said first outgoing direction being a direction on a side of a direction perpendicular to a cyclic direction of said cyclic structure with respect to a normal direction of a light outgoing surface of said linear light guiding body.

2. The lighting system as set forth in claim 1, wherein a tilt is given to the cyclic direction of said cyclic structure with respect to a repeating direction of said pixels.

~~3. The lighting system as set forth in claim 1 or 2,~~

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4. The lighting system as set forth in any one of claims 1 through 3, wherein light from said linear light guiding body reaches a peak value of luminance when outgoing in a second outgoing direction that is different from said first outgoing direction.

5. The lighting system as set forth in claim 4, wherein said first outgoing direction and said second outgoing direction are symmetric with respect to the normal direction of the light outgoing surface of said linear light guiding body.

~~6. The lighting system as set forth in any one of claims 1 through 5, wherein a ratio of maximum value and minimum value in luminance distribution of the light outgoing from said linear light guiding body in said first outgoing direction is not more than 3.~~

7. The lighting system as set forth in claim 4 or 5,
wherein a ratio of maximum value and minimum value in

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luminance distribution of the light outgoing from said linear light guiding body in said second outgoing direction is not more than 3.

8. The lighting system as set forth in any one of claims 1 through 7, wherein an angle that the cyclic direction of said cyclic structure provided on said planar light guiding body forms with respect to the repeating direction of said pixels is not less than 10° and not more than 80° .

9. The lighting system as set forth in any one of claims 1 through 8, wherein in said linear light guiding body, on a surface thereof opposing said light outgoing surface, a propagating portion and a reflecting portion are repetitively formed.

10. The lighting system as set forth in any one of claims 1 through 9, wherein a diffusing and reflecting sheet is provided to surround said linear light guiding body.

11. The lighting system as set forth in any one of claims 1 through 10, wherein:

said light source unit causes the light to enter

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~~said linear light guiding body,~~

~~the lighting system further comprising:~~

~~optical matching means provided between said light source unit and said linear light guiding body.~~

12. The lighting system as set forth in claim 11, wherein said optical matching means is an adhesive resin having a refractive index n ranging from 1.4 to 1.7 both inclusive.

~~13. The lighting system as set forth in any one of claims 1 through 12, wherein said linear light guiding body is formed so that:~~

~~a thickness t_2 of said light outgoing surface of said linear light guiding body is substantially equal to a thickness t_1 of a light incident surface of said planar light guiding body; and~~

~~an angle θ_5 formed between the normal direction of said light outgoing surface with a side end surface of said linear light guiding body satisfies:~~

~~$0^\circ < \theta_5 \leq 20^\circ$~~

14. The lighting system as set forth in any one of claims 1 through 12, wherein said linear light guiding body is tapered so that a cross section of said linear

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light guiding body taken along a plane perpendicular to said light outgoing surface thereof should be in a shape of trapezoid that widens from a light outgoing surface side toward a side opposing the light outgoing surface side.

15. The lighting system as set forth in claim 14, wherein an angle formed between the normal direction of said light outgoing surface of said linear light guiding body with a tapered side surface is larger than 0° and not larger than 20° .

16. The lighting system as set forth in any one of claims 1 through 15, wherein a reflecting surface is provided on said light incident surface of said linear light guiding body in such a manner that light from said light source unit should be reflected toward said cyclic structures formed on said linear light guiding body.

17. The lighting system as set forth in any one of claims 1 through 16, wherein the following relationship is satisfied:

$$0 \text{ mm} < (L2-L1) \leq 10 \text{ mm}$$

where $L1$ representing a length of said light incident surface of said planar light guiding body, and $L2$

~~representing a length of said light outgoing surface of said linear light guiding body.~~

18. The lighting system as set forth in claim 17, wherein the following relationship is satisfied:

$$g \times \tan \theta \leq (L2 - L1) \leq 10 \text{ mm}$$

where:

θ represents an angle formed between the cyclic direction of said cyclic structure provided on said planar light guiding body and the repeating direction of said pixels;

L1 represents a length of said light incident surface of said planar light guiding body;

L2 represents a length of said light outgoing surface of said linear light guiding body; and

g represents a distance between said light incident surface of said planar light guiding body and said light outgoing surface of said linear light guiding body.

~~19. The lighting system as set forth in any one of claims 1 through 18, wherein light outgoing from said linear light guiding body reaches substantially a peak value of luminance when outgoing in a direction at an angle θ_1 that satisfies:~~

$$\theta_1 = \sin^{-1}(n \times \sin \theta)$$

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or

$$\theta_1 = -\sin^{-1}(n \sin \theta)$$

where:

θ represents an angle formed between the cyclic direction of said cyclic structure provided on said planar light guiding body and the repeating direction of said pixels; and

n represents a refractive index of said planar light guiding body.

20. The lighting system as set forth in any one of claims 1 through 18, wherein the normal direction of said light outgoing surface of said linear light guiding body and said first outgoing direction form an angle expressed as:

$$\sin^{-1}(n \sin \theta)$$

where:

θ represents an angle formed between the cyclic direction of said cyclic structure provided on said planar light guiding body and said light incident surface of said planar light guiding body; and

n represents a refractive index of said planar light guiding body.

21. (amended) A lighting system having a light

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source unit and a planar light guiding body, said light source unit being composed of at least one dot light emitting source, said planar light guiding body having a light incident surface to which light from said light source unit is incident and converting light in a linearly emitting state that is incident onto said light incident surface into a planarly emitting state, said lighting system comprising:

sheet-state diffusing means that converts light emitted from said light source unit into a linearly emitting state, said sheet-state diffusing means being provided in the vicinity of said dot light emitting source and arranged so that at least a part thereof opposes said light source unit while at least a part thereof opposes said light incident surface of said planar light guiding body,

wherein:

said at least one dot light emitting source is disposed below the light incident surface of said planar light guiding body so as to face said diffusing means through said planar light guiding body in-between; and

a distance L between said dot light emitting source and said diffusing means, and a thickness t_e of said light incident surface of said planar light guiding body satisfy:

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$$0 \leq (L-te) \leq 10 \text{ mm}$$

22. (amended) A lighting system having a light source unit and a planar light guiding body, said light source unit being composed of at least one dot light emitting source, said planar light guiding body having a light incident surface to which light from said light source unit is incident and converting light in a linearly emitting state that is incident onto said light incident surface into a planarly emitting state, said lighting system comprising:

sheet-state diffusing means that converts light emitted from said light source unit into a linearly emitting state, said sheet-state diffusing means being provided in the vicinity of said dot light emitting source and arranged so that at least a part thereof opposes said light source unit while at least a part thereof opposes said light incident surface of said planar light guiding body,

wherein:

said at least one dot light emitting source is disposed below said light incident surface of said planar light guiding body;

a direction in which light outgoes from said dot light emitting source is set to a normal direction of

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said light incident surface, directed from inside of said planar light guiding body to outside; and

a distance L' between said dot light emitting source and said diffusing means satisfies:

$$0 \leq L' \leq 10 \text{ mm}$$

23. (canceled)

24. (amended) A lighting system comprising:

a planar light guiding body having a light incident surface to which light in a linearly emitting state is incident, said planar light guiding body converting the light in a linearly emitting state that is incident onto said light incident surface into a planarly emitting state; and

a light source unit disposed on a surface opposing to said light incident surface of said planar light guiding body,

said lighting system further comprising:

sheet-state converting means that converts light emitted from said light source unit into a linearly emitting state, said sheet-state converting means being arranged so that at least a part thereof opposes said light incident surface of said planar light guiding body.

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25. (amended) The lighting system as set forth in claim 24, wherein:

said light source unit is composed of at least one dot light emitting source; and

said converting means is diffusing means.

26. (amended) The lighting system as set forth in claim 24, wherein:

said light source unit is composed of at least one dot light emitting source, and

said converting means is reflecting means.

~~27. (amended) The lighting system as set forth in any one of claims 21, 22, 25, or 26, wherein said at least one dot light emitting source constituting said light source unit is composed of an LED element.~~

28. A lighting system having a light source unit and a planar light guiding body, said planar light guiding body having two light incident surfaces opposing each other to which light from said light source unit is

incident as well as a light outgoing surface from which the incident light converted into a planarly emitting state outgoes, said lighting system comprising:

said light source unit is composed of an LED array, wherein:

said LED array includes a first LED array provided on one of said light incident surfaces of said planar light guiding body, and a second LED array provided on the other light incident surface of said planar light guiding body; and

said first and second LED arrays alternately emit light.

29. The lighting system as set forth in claim 28, wherein a frequency f causing said first and second LED arrays to alternately emit light satisfies:

$$60 \text{ Hz} \leq f \leq 10 \text{ kHz}$$

30. A liquid crystal display comprising:

a lighting system as set forth in any one of claims 1 through 29; and

a liquid crystal display element displaying an image by controlling, at each pixel, light outgoing from said light outgoing surface of said planar light guiding body.

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31. A liquid crystal display comprising:

a front light including a light source unit and a planar light guiding body, said planar light guiding body having a light incident surface to which light from said light source unit is incident and a light outgoing surface from which the incident light outgoes, the light from said light source unit being in a linearly emitting state at least when being incident to said light incident surface of said planar light guiding body; and

a reflecting liquid crystal display element displaying an image by controlling, at each pixel, light outgoing from said light outgoing surface of said planar light guiding body,

wherein:

on a counter surface of said planar light guiding body opposing said light outgoing surface thereof, a cyclic structure composed of a propagating portion and a reflecting portion is repetitively formed; and

said cyclic structure is provided on said planar light guiding body so that a cyclic direction thereof has an angle θ of not less than 10° and not more than 80° with respect to the repeating direction of said pixels.

~~32. A front light comprising a lighting system as set forth in any one of claims 1 through 29.~~

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33. The liquid crystal display as set forth in claim 30, wherein said liquid crystal display element is a reflecting liquid crystal display element.

34. A lighting element comprising a prismatic linear light guiding body, said linear light guiding body having a light incident surface to which light from a light source unit is incident and a light outgoing surface from which the incident light outgoes, wherein:

said light incident surface is provided on an end surface of said linear light guiding body, the end surface being at an end in a lengthwise direction;

said light outgoing surface is provided on a side surface of said linear light guiding body along the lengthwise direction;

notches that reflect the incident light are arrayed on a surface of said linear light guiding body opposing said light outgoing surface at constant pitches in the lengthwise direction, the number of said notches being I (I is an integer of not less than 2); and

as to said I notches, an average of differences between widths of adjacent notches is greater than 0, said difference being defined as:

$$\text{DIFFERENCE} = (pw_{i+1} - pw_i)$$

where pw_i is a width of the i'th notch from said light

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incident surface (i is an integer ranging from 1 to I).

35. A lighting element comprising a prismatic linear light guiding body, said linear light guiding body having a light incident surface to which light from a light source unit is incident and a light outgoing surface from which the incident light outgoes, wherein:

said light incident surface is provided on an end surface of said linear light guiding body, the end surface being at an end in a lengthwise direction;

said light outgoing surface is provided on a side surface of said linear light guiding body along the lengthwise direction;

notches that reflect the incident light are arrayed on a surface of said linear light guiding body opposing said light outgoing surface in the lengthwise direction, the number of said notches being I (I is an integer of not less than 2); and

an average of tilts of said I notches is greater than 0, said tilt being defined as:

$$\text{TILT} = (d_{i+1} - d_i) / (x_{i+1} - x_i)$$

where x_i and d_i are a distance from said light incident surface, and a depth, respectively, of the i'th notch from said light incident surface (i is an integer ranging from 1 to I).

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36. The lighting element as set forth in claim 35, wherein said average of tilts of said I notches is in a range of not less than 0.0001 and not more than 0.05.

37. The lighting element as set forth in claim 35 or 36, wherein values of said tilts are uniform throughout said I notches.

38. The lighting element as set forth in any one of claims 34 through 37, wherein, on the surface of said linear light guiding body opposing said light outgoing surface, a total of widths of said notches in the lengthwise direction accounts for not less than 5 percent and not more than 80 percent of a sum of the total of said widths of said notches and a total of widths of flat portions provided between said notches.

39. The lighting element as set forth in any one of claims 34 through 38, wherein, on the surface of said linear light guiding body opposing said light outgoing surface, a sum of a width of said notch in the lengthwise direction and a width of a flat portion in the lengthwise direction is not less than 0.05 mm and not more than 2 mm, the flat portion being a portion provided between said notch and another adjacent notch on one side to said

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40. The lighting element as set forth in any one of claims 34 through 39, wherein:

said linear light guiding body has a second light incident surface on an end surface opposing said light incident surface of said linear light guiding body;

notches that reflect the incident light are arrayed in the lengthwise direction on a surface of said linear light guiding body opposing said light outgoing surface, the number of said notches being J (J is an integer of not less than 2); and

an average of tilts of said J notches is greater than 0, said tilt being defined as:

$$\text{TILT} = (d_{j+1} - d_j) / (x_{j+1} - x_j)$$

where x_i and d_i are a distance from said light incident surface, and a depth, respectively, of the j'th notch from said second light incident surface (j is an integer ranging from 1 to I).

41. A lighting element comprising a prismatic linear light guiding body, said linear light guiding body having a light incident surface to which light from a light source unit is incident and a light outgoing surface from which the incident light outgoes, wherein:

said light incident surface is provided on an end surface of said linear light guiding body, the end surface being at an end in a lengthwise direction;

said light outgoing surface is provided on a side surface of said linear light guiding body along the lengthwise direction;

a plurality of notches that reflect the incident light are arrayed on a surface of said linear light guiding body opposing said light outgoing surface in the lengthwise direction;

each notch is a V-shape groove formed with two flat surfaces;

said flat surfaces of said notches are provided at not less than two different angles with respect to said light outgoing surface.

42. The lighting element as set forth in any one of claims 34 through 41, wherein:

each of said notches is a V-shape groove formed with two flat surfaces; and

an angle that each flat surface forms with respect to said light outgoing surface is not less than 30° and not more than 60°.

43. The lighting element as set forth in any one of

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